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# Long-Term Results After Laser Turbinectomy

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***Background and Objective:*** **Different types of lasers have been used for reduction of hypertrophic inferior turbinates in recent years with good results. Reports about the long-term benefits of the laser treatment are rare.**
***Study Design/Materials and Methods:*** **At the Department of Otorhinolaryngology, Head and Neck Surgery, University of Kiel, from April 1987 to March 1997, 658 patients with nasal obstruction caused by hypertrophic inferior turbinates were treated with the $CO_2$ or Nd:YAG laser. Of these patients, 118 were able to be followed for a period of 5 years.**
***Results:*** **After 5 years, 54 of 70 patients (77.1%) treated with the $CO_2$ laser were satisfied. The success rate after Nd:YAG laser surgery was 64.6% (31/48 patients). Severe intra- or postoperative complications were not observed.**
***Conclusion:*** **The results suggest that the $CO_2$ and Nd:YAG laser surgical techniques are suitable for the treatment of hypertrophic inferior turbinates. The main advantages are the decreased bleeding risk and the fact that the operation can be conducted as an outpatient procedure. Lasers Surg. Med. 22: 126–134, 1998.** **© 1998 Wiley-Liss, Inc.**

**Key words: allergy; $CO_2$ laser; hypertrophic turbinates; long-term results; Nd:YAG laser; vasomotoric rhinitis**

## INTRODUCTION

Chronic nasal airway obstruction is one of the most frequent symptoms with which an otorhinolaryngologist is confronted. Most of these patients suffer from hypertrophied inferior turbinates as a result of allergic or vasomotor rhinitis [1]. Conservative, systemic, and topical approaches such as decongestants, antihistamines, steroids, or desensitization relieve the suffering for only short amounts of time. In many cases, therefore, surgical treatment is necessary [2].

A variety of surgical procedures have been described for treating hypertrophied inferior turbinates [3]. The disadvantages of every conventional technique are a distinct risk of bleeding, damage to the mucosa, which can be extensive, atrophic rhinitis [4], and the uncertainty of long-term success [5,6].

Since the early 1980s, different laser systems have been used increasingly and, to some extent successfully, to shrink turbinates [7–13]. The advantages of the laser surgical procedure include lack of bleeding and limited tissue trauma as well as the ability to offer it as an outpatient treatment [2,14]. Comparative studies of conventional therapeutical procedures have proved the laser surgical techniques, including long-term success, to be very promising [3,5]. The few reports hereto refer, however, to low numbers of cases and, in part, to follow-up examinations over a too short period of time. In this report, 5-year results after laser turbinectomies are presented for the first time.

## MATERIALS AND METHODS

From April 1987 to March 1997, 658 patients with chronic nasal airway obstruction due to hy-

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pertrophied inferior turbinates were treated with a $CO_2$ or a Nd:YAG laser at the Kiel University Department of Otorhinolaryngology, Head and Neck Surgery. Of these patients, 118 (72 women, 46 men, average age 36,4 years) were able to be examined postoperatively over a 5-year period. The turbinectomies were done on 70 patients with a $CO_2$ laser and on 48 with the Nd:YAG laser; 76 of the cases were due to a perennial allergy to housedust mites and 42 cases due to vasomotor rhinitis. All patients were treated unsuccessfully with conservative therapies, including desensitization. Other pathological changes, such as chronic sinusitis or a deviated septum leading to nasal airway obstruction, were ruled out.

Laser turbinectomies were deemed necessary when the nasal airway obstruction was due to hyperplastic mucosa and not to an enlarged inferior nasal turbinate. To determine whether nasal obstruction was primarily due to hyperplastic mucosa rather than a hypertrophied turbinate bone, a rhinomanometry (Atmos Medizintechnik, Germany) was used to quantify the mucosal portion obstructing nasal respiration. The active anterior method was applied. Right and left nasal cavities were measured separately at reference pressures of 75 and 150 Pascal (Pa), and the computer calculated the total nasal resistance.

After initial rhinomanometry in the swollen state, naphazoline nitrate solution (1:1,000) was applied to the mucosa of the inferior turbinates, first to the head of the turbinate, then to the middle third, and finally to the posterior third. Rhinomanometry was done 10 minutes after decongestion of each respective region. If rhinomanometry after decongestion showed a decrease of the total airway resistance of >20%, laser treatment seemed to be successful.

In addition, the patient was asked to rate nasal breathing subjectively. Turbinate reduction by laser surgery was pursued only if the patient's subjective impression indicated clearly improved nasal breathing after turbinate decongestion [15]. The $CO_2$ laser was used on a hyperplastic turbinate tip, the Nd:YAG laser on a completely hypertrophic inferior turbinate.

Laser surgery was performed under local anesthesia as an outpatient or office procedure. The local anesthesia of the nasal mucosa consisted of inserting 4% Lidocaine-soaked cotton pledgets into the nasal passageways and infiltrating the inferior nasal turbinate with 1% Lidocaine after 10 minutes for the Nd:YAG laser procedure, because a swollen mucosa has a better absorption of the laser light. For the $CO_2$ laser, 1/100,000 Adrenalin could be added.

The technique of $CO_2$ and Nd:YAG laser surgery turbinectomies has recently been described [16,17]. In short: up to 10 single sports (1–2 W; 1 sec; power density; 2,038 W/cm$^2$) are applied to the hyperplastic turbinate. The application occurs with a micromanipulator (Acuspot 711; Sharplan Lasers, Munich, Germany) with a focus diameter of 0.25 mm under microscopic control. Either a self-retaining nasal retractor or a nasal retractor with integrated suction was used (Fig. 1a,b). During the laser procedure, shrinking of the turbinate was visible. The turbinate treatment with the Nd:YAG laser was carried out with a special laserrhinoscope (Fig. 2a,b) [18]. The hypertrophic inferior turbinate was irradiated in its entirety with the noncontact technique (5–10 W; 600 μm bare fiber; power density: 3,540 W/cm$^2$), until the mucosa went pale (Fig. 2c).

A nose tampon was used regularly until 1992, but after 1993, only for intense interoperative bleeding, or for very anxious and nervous patients from remote areas. All the patients were advised to use decongestants for the first 3 postoperative days and to rinse crusts from the nasal passages with a saline solution twice a day after the third day. There was no prophylactic medication with antibiotics.

All the patients were examined weekly during the first 6 weeks. Further postoperative examinations were given at 6 months and then once a year for 5 years after the operation. Each time, a nose endoscopy and a rhinomanometry to determine the objectivity of nasal breathing were done. The patients also answered a questionnaire, standardized in accordance with von Haacke [19] and Warwick-Brown [5], which contained the following questions:

1. Was the operation a success?
2. Which complaints were improved by the operation?
3. For how long did the success of the therapy last?
4. Were there any complications after the operations, like dry nasal mucous membranes, formation of crusts, nose bleeds, or the formation of unpleasant odors?
5. Would you have the operation done again?

Fig. 1. **(A)** The self-retaining retractor provides an excellent exposure of the nasal cavity. The surgeon can use both hands, one to hold the suction for removing vapors from the operating field and the other to move the laser joy stick. The use of **(B)** the nasal speculum with suction is also possible.

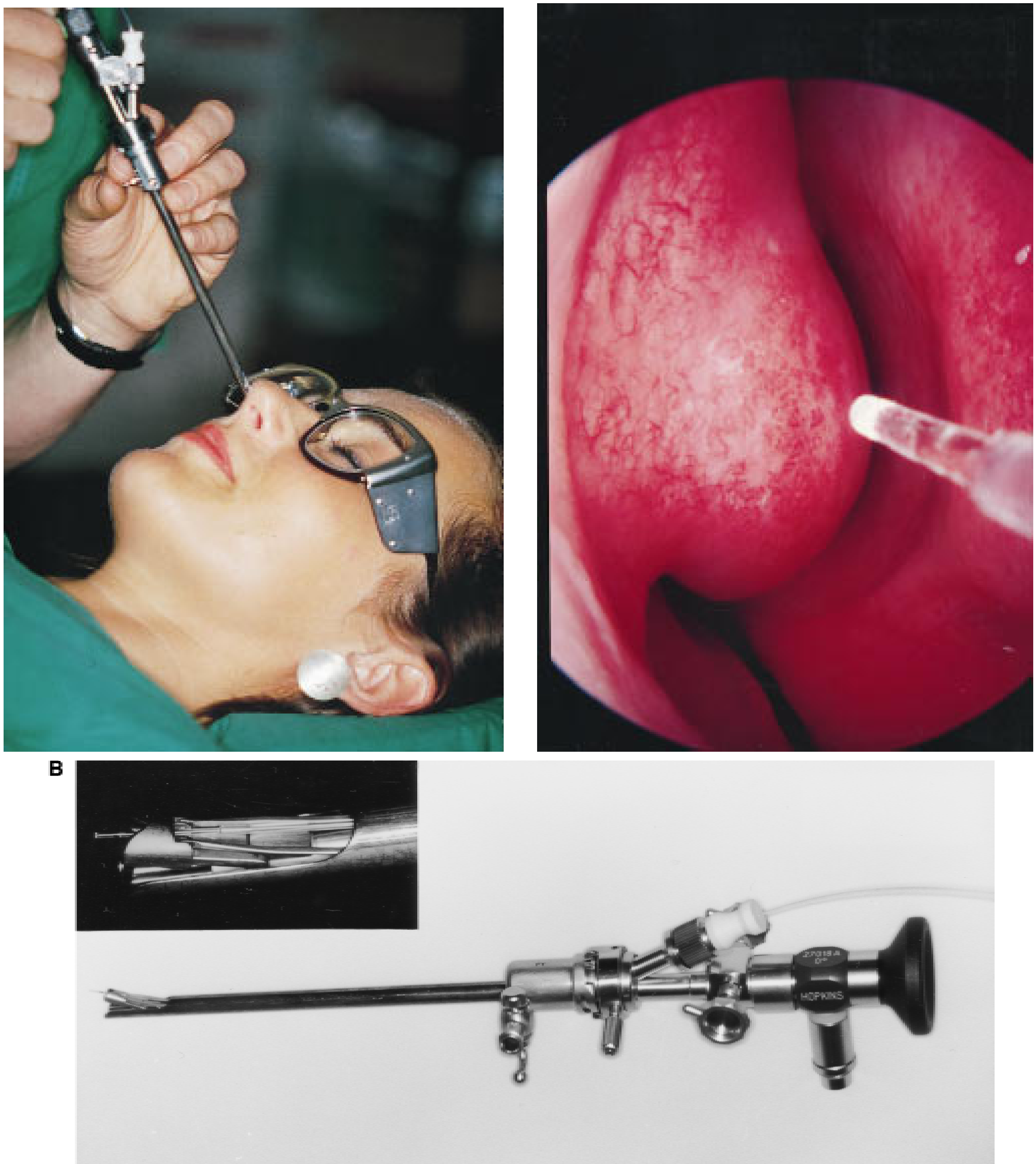


Fig. 2. **(A)** Nd:YAG laser treatment with a laser rhinoscope. **(B)** Through the endoscopic sheath, the laser fiber may be passed and angulated. The rhinoscope is also containing suction channels for smoke evacuation. **(C)** Intranasal view of the right inferior turbinate with the tip of the bare fiber.

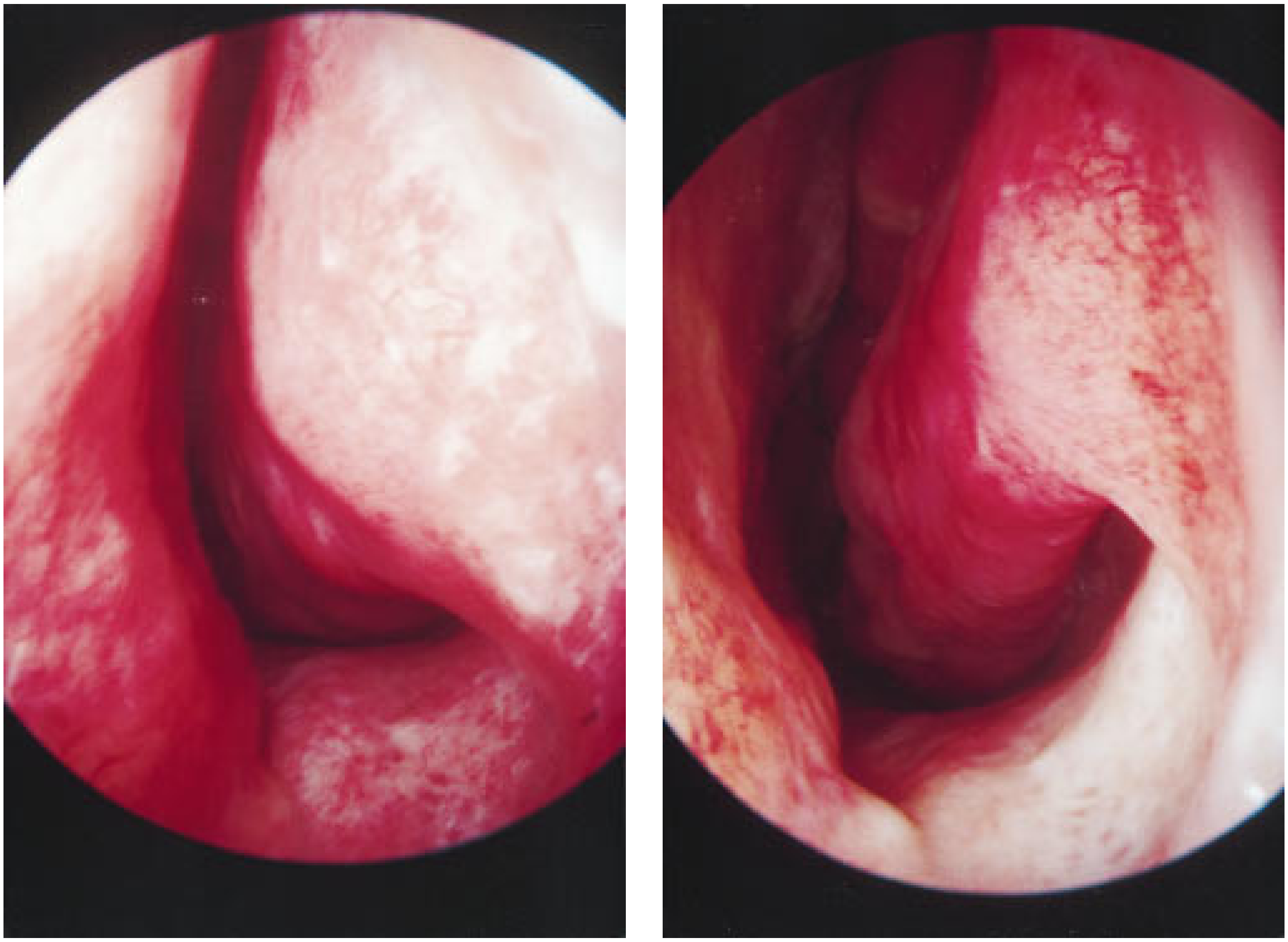

Fig. 3. **(A)** Preoperative view of the left inferior turbinate. **(B)** Six weeks after $CO_2$ laser surgery. The volume of the turbinate is reduced, the middle turbinate is visible.

## RESULTS

The postoperative period varied according to the type of laser used. With the $CO_2$ laser, an improvement in the nasal airways was seen after 1 week; after 2 weeks, the positive effect was even better. The final result of the treatment was reached after 2–4 weeks (Fig. 3a,b). The length of the postoperative wound care was 8–10 days. In comparison, after the Nd:YAG laser treatment, there was a marked deterioration of the nasal airways. Breathing through the nose was almost impossible during the first week and even after the second week, the preoperative level had not been reattained. However, 6 weeks after the laser treatment, the nasal airway obstruction did improve markedly in comparison to the initial findings. The final result of the treatment was reached after 4–6 months. There were always fibrine exudations, which made a regular wound care necessary, lasting sometimes up to several weeks. In >90% of the treated cases, the wounds were completely healed after 4–5 weeks.

The rate of complications due to the laser surgical procedure was low (Table 1). Heavy interoperative bleeding was observed very rarely; postoperative bleeding did not occur. In one case after Nd:YAG laser treatment, a synechia needing treatment developed between the septum and the inferior turbinate. None of the patients reported dry nasal mucosa, crust formation, nose bleeds, or unpleasant odor formation after the wound healing phase; 82.9% (58/70) of the patients treated with the $CO_2$ laser consented to a repeat of the treatment, and 36 of the 48 (75%) patients would agree to a second treatment with the Nd:YAG laser.

The therapy outcome after the $CO_2$ and the

**TABLE 1. Complications After Laser Turbinectomy**

| | $CO_2$ laser (n = 70) | Nd:YAG laser (n = 48) |
|---|---|---|
| Intraoperative bleeding | 3 | 1 |
| Postoperative bleeding | — | — |
| Synechia | — | 1 |
| Dry nasal mucosa | — | — |
| Unpleasant odor | — | — |

**TABLE 2. Long-Term Results After Turbinectomy With $CO_2$ and Nd:YAG Lasers**

| Postoperative period | $CO_2$ laser (n = 70) | Nd:YAG laser (n = 48) |
|---|---|---|
| 6 months | 60 (85,7%) | 32 (66,6%) |
| 1 year | 57 (81,4%) | 34 (70,8%) |
| 2 years | 55 (78,6%) | 32 (66,6%) |
| 3 years | 55 (78,6%) | 31 (64,6%) |
| 4 years | 54 (77,1%) | 31 (64,6%) |
| 5 years | 54 (77,1%) | 31 (64,6%) |

**TABLE 3. Nasal Airway Resistance Before and 5 Years After $CO_2$ and Nd:YAG Laser Treatment***

| | Nd:YAG laser (n = 28) Total airway resistance | | $CO_2$ laser (n = 53) Total airway resistance | |
|---|---|---|---|---|
| Parameter | Pre-op Mean (SD) | Post-op Mean (SD) | Pre-op Mean (SD) | Post-op Mean (SD) |
| 75 Pa | 0.58 (0.32) | 0.41 (0.25) | 0.54 (0.38) | 0.35 (0.24) |
| 150 Pa | 0.72 (0.41) | 0.38 (0.27) | 0.68 (0.31) | 0.32 (0.21) |

*Nasal airway resistance is expressed in Pa/cm3/sec. Data of 81 patients were completely available.

**TABLE 4. Subjective Assessments of Nasal Breathing 5 Years After Laser Turbinectomies**

| | $CO_2$ laser (n = 70) | Nd:YAG laser (n = 48) |
|---|---|---|
| Excellent | 34 (48,6%) | 8 (16,7%) |
| Distinctly improved | 9 (12,8%) | 12 (25%) |
| Satisfactory | 11 (15,7%) | 11 (22,9%) |
| Unsatisfactory | 16 (22,9%) | 17 (35,4%) |

Nd:YAG laser treatments of the inferior turbinate was different (Table 2). Six months after therapy, 50 (85.7%) of those patients treated with the $CO_2$ laser were free of complications. After a year, 57 (81.4%); after 2 and 3 years, 55 (78.6%) were satisfied with the result of the operation. Five years after the $CO_2$ laser therapy, 54 patients (77.1%) reported well-being. Six months after completion of the Nd:YAG laser therapy, 32 (66.6%) patients reported a marked improvement of the nasal airways obstructions; after a year, 34 (70.8%) and after 2 years, 32 (66.6%). The positive effect lasted 5 years in 31 patients (64.6%). The long-term results showed no difference between patients with allergic and vasomotor rhinitis. The mean values of the nasal airway resistance of 81 patients are described in Table 3. There were differences in the nasal airway resistance between pre- and postoperative measurement showing an improvement of the nasal breathing. The rhinomanometric results correlated only in 58% with the patient's perception.

The outcome of the therapy after 5 years was graded by the patients as follows: 48.6% of the patients treated with the $CO_2$ laser were very satisfied, 12.8% reported a significant improvement in nasal breathing, and 15.7% designated the outcome as satisfactory. Of the Nd:YAG laser patients, 16.7% were completely free of complications, 25% reported an improvement of the complaints, and 22.9% were satisfied with the outcome of the treatment (Table 4).

## DISCUSSION

A series of different operational techniques for the treatment of hyperplastic inferior turbinates have been discussed, such as submucosal turbinectomy, inferior turbinoplastic, conchotomy, turbinate lateralization, submucosal diathermy, cryotherapy, or vidian neurectomy [20,21].

Different laser systems have been implemented for turbinate reduction. The argon laser [7] has by far the most experience. In addition, there have been reports of the successful application of the $CO_2$ laser [22,23], the KTP laser [24], the Ho:YAG laser [25], the magnet laser [26], the diode laser [27], and the Nd:YAG laser [9,28]. The prerequisite for a laser surgical treatment of hypertrophic inferior turbinates is that the cause of the nasal airways obstruction is predominantly due to mucosal swelling of the inferior turbinate. The use of the Nd:YAG laser is justified if the mucosal swelling affects the entire turbinate. The flexible fiber, guided by the laserrhinoscope, makes the treatment of the posterior turbinates possible. In contrast, because of the straight beam, the $CO_2$ laser is especially suitable [13] for the reduction of the hyperplastic turbinate tip.

In the literature, different techniques of reducing turbinates with the $CO_2$ and the Nd:YAG laser have been described [1,3,8]. Our own investigations have proved the single spot technique to be the most suitable for the $CO_2$ laser [17]. Single laser spots are applied to the swollen turbinate

tip, which results in shrinking of the mucosa with subsequent scarring. A small carbonization and necrosis zone develops from the laser light application with reduced power and focus. This results in a limited tissue traumatization with safely intact mucosa islands between the laser spots, from which fast reepithelization proceeds [4,24]. Pronounced scar formation, which can lead to a functional impairment of the turbinate mucosa ranging from relapsed crust formations to atrophic rhinitis, is avoided herewith. This is clinically obvious by the distinct reduction of postoperative crust formation and the length of the postoperative wound care. However, a moderate scar formation is desirable, especially in allergic rhinitis, in order effectively to stop the allergic reactions localized in the submucosa [8,23]. Clinically, the laser treatment shows a decrease of allergic symptoms. Furthermore, in >60% of the allergic patients, the antiallergic drugs could be reduced.

Unlike the $CO_2$ laser, the turbinate treatment is carried out in the noncontact technique with the Nd:YAG laser on low power settings. The immediate effect of the laser light action should be recognizable as only a tiny paling of the mucosa [16]. The Nd:YAG laser light penetrates the tissues to a depth of 10 mm and is absorbed in the cavernous body of the submucosal vascular network of the turbinate [18,29]. Vasculitis is the result, which is followed by protracted scarring with secondary shrinking and a reduction of the turbinate's potential for swelling [30]. After a low dose Nd:YAG laser treatment, the ciliated epithelium of the nasal mucosa remains largely intact. The mucociliary clearance of the nasal mucous membranes is not impaired [3]. Histologically, the production of glycoproteins in the epithelial beaker cells appears undiminished, as we could demonstrate in previous investigations [16].

The postoperative phase is different for both types of lasers. After a turbinectomy with the $CO_2$ laser, a marked improvement of nasal breathing occurs within a few days. The postoperative crust formation is slight, and with it the necessary postoperative wound care is also reduced. In comparison to the $CO_2$ laser, the low dose Nd:YAG laser treatment produces a reactive swelling of the turbinate mucosa, which results at first in a deterioration of nasal breathing. Because of this, a distinctly positive effect on nasal breathing can be expected only in the postoperative phase after some weeks [31]. This can be explained by the gradual regression of the reactive mucosa edema and the slowly commencing submucosal scarring process, which is complete after 4–6 months [18]. Also, the fibrine incrustations, which can be very pronounced, require regular follow-up care over the course of several weeks. The patient should be informed of this prior to therapy.

The long-term results are crucial for an assessment of an operational procedure. In most articles, the length of time of the observations is confined to 1 or 2 years [2,10,32]. It is known, however, that nasal airway obstruction can appear again in patients, especially after >2 years [6]. These patients are not registered then in the follow-up, and the success of the therapy is rated too high as a result [5]. Laser surgery treatments are superior to conventional treatments [33,34]. The results of a postoperative observation over a 5-year length of time have not yet been submitted. The evaluation of the treatment success is difficult. Long-term adaptation to nasal obstruction could be expected to lead to poor correlation between subjective and objective parameters. Both rhinomanometry and a clinical examination by the operating surgeon have proved to be pointless [35].

In principle, it should be easy to calculate nasal airway resistance by measurement the pressure gradient and air flow through the nasal cavities. In practice, several factors, such as changes in mucosal swelling, position of the soft palate, form of the nostril, and technical difficulties such as leakage and occlusion, can affect the results and make assessment more complicated [36]. Reproducibility can be poor. This can lead to discrepancies between renomanometric results and patient perception. In our patients, the rhinomanometric results correlated only in 58% with the patient perception. The treatment success was, therefore, rated mostly on the basis of a questionnaire.

The long-lasting success of the operation after a laser turbinectomy with a $CO_2$ laser (77.1% after 5 years) can be best explained by the special operation technique of treating the entire surface of the turbinate tip and aiming for a scar formation over the entire area. These results are in accordance with results of other authors [8,23] and show that no significant changes in the success rate appear 2 years after laser therapy. It is especially remarkable that >60% of the patients who considered the turbinectomy a success also rated the operational result as "excellent." The long-term success after the treatment with the Nd:YAG laser is somewhat lower at 65%, but is superior to the electrocautery treatment by a

needle electrode [13]. This is mostly due to selectively damaging the tissue contained in the submucosal vein plexus and the muscle fibers located there. These muscle fibers are tied up functionally in the complex proceedings of vasodilatation and vasoconstriction and are ultimately responsible for the swelling and shrinking of the nasal mucosa [37]. Damaging the muscle fibers results not only in a direct impact of the Nd:YAG laser on the vein plexus, but also a further restriction of the swelling capacity by the Nd:YAG laser beam. Most patients reported permanent improvement in nasal breathing as well as the alleviation of accompanying symptoms such as watery rhinorrhoea, sneezing attacks, or headaches.

The rate of complications after laser turbinectomy is low. Intra- and postoperative bleeding, described especially in conventional techniques, was not observed. Only one case of Nd:YAG laser treatment resulted in the formation of a synechia due to heavy fibrine formation. There were no undesirable side effects in the long-term course, such as dry mucosa with recurrent crust formation; 82.9% of the patients treated with the $CO_2$ laser and 75% of those treated with the Nd:YAG laser would agree to a second laser treatment. This high acceptance of laser surgery can be explained on one side by its great effectivity and on the other side by the small amount of stress on the patient, who can be treated quickly and almost painlessly as an outpatient.

The $CO_2$ laser and the Nd:YAG laser are suitable for the treatment of chronic allergic and vasomotor rhinitis with hypertrophic inferior turbinates. The prerequisite is that the nasal obstruction is due to a swollen mucosa of the turbinate. Contrary to conventional techniques, the laser turbinectomy can be done in an outpatient office setting with a local anesthetic, due to the limited traumatization of the tissue. Nose tampons are usually not necessary. The long-term results are good and superior to conventional surgical procedures.

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